H. GEOLOGY

This section assesses the project area's geologic environment based on the inspection of current site conditions, published and unpublished geologic reports, and maps. This section also assesses potential impacts from strong ground shaking, liquefaction, and differential settlement that could result from seismic activity.

1. Setting

The project area is located at the western coastal margin of the Coast Range Geomorphic Province of Northern California. This region is dominated by northwest-southeast trending ranges of low mountains and intervening valleys. The project area is within the San Andreas Fault Zone, an area of active seismicity.

a. Geologic Setting. Existing topographical, geological and soils conditions are summarized below.

(1) Topography. The project area is located in the northern portion of the Santa Clara Valley. This portion of the valley is a relatively large alluvial plain formed along the Guadalupe River and its major tributaries, including Los Gatos Creek. The valley is approximately 15 miles wide, bounded on the west by the Santa Cruz Mountains, to the east by the Diablo Range, and to the north by San Francisco Bay; this valley includes the project area. The project area is relatively flat and elevations are generally less than 100 feet above mean sea level. The most significant topographic features within the project area are the channels of the Guadalupe River and Los Gatos Creek. These channels are urbanized streams that have historically been managed as floodways which have been straightened and steepened to increase conveyance capacity.

(2) Geology. The geologic setting of the Santa Clara Valley is a crustal depression filled with alluvial sediments transported and deposited by streams draining the adjacent upland areas. The basin has formed in response to tectonic warping during the last five million years. The alluvial deposits consist of unconsolidated to semi-consolidated sand, silt, clay, and gravel. In the project area, the alluvial sediments are up to 1,500 feet thick.[1] The older deposits, which are exposed at the margins of the valley, include the semi-consolidated Santa Clara Formation. These older sediments are overlain by the more recent flood plain deposits that directly underlie the project area.[2]

(3) Soils. The alluvial deposits of the Santa Clara Valley are covered by surface soils that reflect the characteristics of the underlying soils on which the soil is developed. In the project area, the surface soils have been mapped by the Natural Resource Conservation Service (formerly the Soil Conservation Service [SCS]) as Yolo association soils. These soils are moderately well- to somewhat

[1] Poland, J., 1971. Land Subsidence in the Santa Clara Valley, Alameda, San Mateo, and Santa Clara Counties, California, U.S. Geological Survey Open-File Report OF-84-818.

[2] Helley, E., Graymer, R., Phelps, G., Showalter, P, and Wentworth, C., 1994. Quaternary Geology of Santa Clara Valley, Santa Clara, Alameda, and San Mateo Counties, California, U.S. Geological Survey Open-File Report OF-94-231, scale 1:50000 (digital database).

excessively-drained and medium-to-fine textured. The infiltration rate is slow and the shrink-swell potential is moderate.[3]

b. Seismic Conditions. The project area is located near the San Andreas Fault Zone (SAFZ), a complex of active faults forming the boundary between the North American and Pacific lithospheric plates. Movement of the plates relative to one another results in the accumulation of strain along the faults, which is released during earthquakes. Numerous moderate to strong historic earthquakes have been generated in northern California by the SAFZ. The level of active seismicity results in classification of the area of seismic risk Zone 4 (the highest risk category) in the California Building Code.

The SAFZ includes numerous active faults found by the California Division of Mines and Geology under the Alquist-Priolo Earthquake Faults Act to be "active" (i.e., to have evidence of fault rupture in the last 11,000 years). Regional active faults located in the vicinity of the project area are shown on Figure V.H-1.

The 2002 Working Group on California Earthquake Probabilities has determined that there is a 62 percent chance (±10 percent) of a magnitude 6.7 or greater earthquake occurring on one of the major faults within the San Francisco Bay region before 2032.[4] Furthermore, they determined that there is a 27 percent chance of a magnitude 6.7 or greater earthquake occurring along the Hayward-Rodgers Creek combined fault zone and a 23 percent chance of a similar quake on the San Andreas fault before 2032.

(1) Surface Rupture. Surface rupture occurs when the ground surface is broken due to fault movement during an earthquake. The location of surface rupture generally can be assumed to be along an active or potentially active major fault trace. No active faults have been mapped in the project area. Therefore, potential for fault rupture at the site is negligible, and no portion of the project area is located within an Alquist-Priolo Special Study Zone.

The closest active fault to the project area is the Hayward fault zone, located approximately 5.3 miles to the east-northeast. Other potentially damaging active faults are located within ten miles of the project area, including the San Andreas, MonteVista-Shannon, and Calaveras faults.

(2) Ground Shaking. Ground shaking is a general term referring to all aspects of motion of the earth's surface resulting from an earthquake, and is normally the major cause of damage in seismic events. The extent of ground shaking is controlled by the magnitude and intensity of the earthquake, distance from the epicenter, and local geologic conditions. Magnitude is a measure of the energy released by an earthquake; it is assessed by seismographs that measure the amplitude of seismic waves. In the past, the common standard for measurement of magnitude (M_L) by geologists and seismologists was the Richter Scale. However, due to limitations of the instrumentation used to measure Richter magnitude, scientists now use moment magnitude (M_W) to characterize seismic

[3] United States Department of Agriculture Soil Conservation Service, 1958. *Soil Survey of Santa Clara County, California.*

[4] United States Geological Survey (USGS), 2003. Earthquake Probabilities in the San Francisco Bay Region: 2002 to 2032 – A Summary of Findings, Open File Report 03-214.

Figure V.H-1: Regional Active Earthquake Faults

8½ x 11, Black & white

events. Moment magnitude is determined on the basis of the area of the rupture of the fault plane, the average displacement along the fault plane, and the resistance of the faulted rock to faulting. Both magnitude scales are logarithmic and each successively higher magnitude reflects an increase of about 32 times the amount of energy released by an earthquake.

Intensity is a more subjective measure of the perceptible effects of seismic energy at a given point and varies with distance from the epicenter and local geologic conditions. The Modified Mercalli Intensity Scale (MMI) (Table V.H-1) is the most commonly used scale for measurement of the subjective effects of earthquake intensity. Intensity can also be quantitatively measured using accelerometers (strong motion seismographs) that record ground acceleration at a specific location, a measure of force applied to a structure under seismic shaking. Acceleration is measured as a fraction or percentage of the acceleration under gravity (g).

Estimates of the peak ground acceleration have been made for the project area based on probabilistic models that account for multiple seismic sources. Under these models, consideration of the probability of expected seismic events is incorporated into the determination of the level of ground shaking at a particular location. The expected peak horizontal acceleration (with a 10 percent chance of being exceeded in the next 50 years) generated by any of the seismic sources potentially affecting the Greater Downtown area, is estimated by the California Geological Survey (formerly the California Division of Mines and Geology) as approximately 0.5 to 0.6g.[5] The associated intensity for this range of acceleration would be MMI VIII-IX, very strong to violent levels of ground shaking.

The Association of Bay Area Governments (ABAG) estimates that the intensity of ground shaking at the project area during an M 6.7 earthquake on the southern segment of the Hayward fault would be MMI VII-VIII (strong to very strong).[6] The difference in estimates for the estimated level of shaking probably reflects minor differences in the assumption regarding the characteristics of the expected earthquake and the subsurface conditions within the project area. The expected level of ground shaking at the project site is a potentially serious hazard.

(3) Liquefaction. Liquefaction is the temporary transformation of loose, saturated granular sediments from a solid state to a liquefied state as a result of seismic ground shaking. In the process, the soil undergoes transient loss of strength, which commonly causes ground displacement or ground failure to occur. Since saturated soils are a necessary condition for liquefaction, soil layers in areas where the groundwater table is near the surface have higher liquefaction potential than those in which the water table is deep. The entire project area is within a “liquefaction zone” mapped by the California Geological Survey in conformance with the Seismic Hazards Mapping Act.[7,8] This zone is characterized as an area “where historic occurrence of liquefaction or local geological, geotechnical and groundwater conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.”

[5] California Geological Survey, 2003. Probabilistic Seismic Hazards, San Jose 1 x 2 Degree Sheet.

[6] Association of Bay Area Governments, 2003. Shaking Intensity Map, North and Central San Jose, South Hayward Segment of the Rodgers Creek-Hayward Fault, http://www.abag.ca.gov/bayarea/eqmaps.

[7] California Geological Survey, 2002. Seismic Hazard Zones, San Jose East Quadrangle, 1:24,000

[8] Ibid.

Table V.H-1: Modified Mercalli Scale[a]

	Intensity	Effects	v,[b] cm/s	g[c]
M[d]	I.	Not felt. Marginal and long-period effects of large earthquakes.		
3	II.	Felt by persons at rest, on upper floors, or favorably placed.		
	III.	Felt indoors. Hanging objects swing. Vibration like passing of light trucks. Duration estimated. May not be recognized as an earthquake.		0.0035-0.007
4	IV.	Hanging objects swing. Vibration like passing of heavy trucks; or sensation of a jolt like a heavy ball striking the walls. Standing motor cars rock. Windows, dishes, doors rattle. Glasses clink. Crockery clashes. In the upper range of IV wooden walls and frame creak.		0.007-0.015
	V.	Felt outdoors; direction estimated. Sleepers wakened. Liquids disturbed, some spilled. Small unstable objects displaced or upset. Doors swing, close, open. Shutters, pictures move. Pendulum clocks stop, start, change rate.	1-3	0.015-0.035
5	VI.	Felt by all. Many frightened and run outdoors. Persons walk unsteadily. Windows, dishes, glassware broken. Knickknacks, books, etc., off shelves. Pictures off walls. Furniture moved or overturned. Weak plaster and masonry D cracked. Small bells ring (church, school). Trees, bushes shaken (visibly, or heard to rustle - CFR).	3-7	0.035-0.07
6	VII.	Difficult to stand. Noticed by drivers of motor cars. Hanging objects quiver. Furniture broken. Damage to masonry D, including cracks. Weak chimneys broken at roof line. Fall of plaster, loose bricks, stones, tiles, cornices (also unbraced parapets and architectural ornaments - CFR). Some cracks in masonry C. Waves on ponds; water turbid with mud. Small slides and caving in along sand or gravel banks. Large bells ring. Concrete irrigation ditches damaged.	7-20	0.07-0.15
	VIII.	Steering of motor cars affected. Damage to masonry C; partial collapse. Some damage to masonry B; none to masonry A. Fall of stucco and some masonry walls Twisting, fall of chimneys, factory stacks, monuments, towers, elevated tanks. Frame houses moved on foundations if not bolted down; loose panel walls thrown out. Decayed piling broken off. Branches broken from trees. Changes in flow or temperature of springs and wells. Cracks in wet ground and on steep slopes.	20-60	0.15-0.35
7	IX.	General panic. Masonry D destroyed; masonry C heavily damaged, sometimes with complete collapse; masonry B seriously damaged. (General damage to foundations - CFR.) Frame structures, if not bolted, shifted off foundations. Frames racked. Serious damage to reservoirs. Underground pipes broken. Conspicuous cracks in ground. In alluviated areas sand and mud ejected, earthquake foundations, sand craters.	60-200	0.35-0.7
8	X.	Most masonry and frame structures destroyed with their foundations. some well-built wooden structures and bridges destroyed. Serious damage to dams, dikes, embankments. Large landslides. Water thrown on banks of canals, rivers, lakes, etc. Sand and mud shifted horizontally on beaches and flat land. Rails bent slightly.	200-500	0.7-1.2
	XI.	Rails bent greatly. Underground pipelines completely out of service.		>1.2
	XII.	Damage nearly total. Large rock masses displaced. Lines of sight and level distorted. Objects thrown into the air.		

[a] From Richter (1958).
[b] Average peak ground velocity, centimeters per second (cm/s).
[c] Average peak acceleration (away from source).
[d] Richter magnitude correlation.

Note: *Masonry A, B, C, D.* To avoid ambiguity of language, the quality of masonry, brick or otherwise, is specified by the following lettering (which has no connection with the conventional Class A, B, C construction).

- *Masonry A:* Good workmanship, mortar, and design, reinforced, especially laterally, and bound together by using steel, concrete, etc; designed to resist lateral forces.
- *Masonry B:* Good workmanship and mortar, reinforced, but not designed to resist lateral forces.
- *Masonry C:* Ordinary workmanship and mortar; no extreme weaknesses such as non-tied-in corners, but masonry is neither reinforced nor designed against horizontal forces.
- *Masonry D:* Weak materials, such as adobe; poor mortar; low standards of workmanship; weak horizontally.

Regional mapping and hydrogeologic conditions indicate that the uppermost groundwater table (an unconfined aquifer in Quaternary alluvial deposits) occurs at shallow depths in the area of the proposed project.[9] The depth to groundwater in the northern portion of the project area varies between approximately 15 and 22 feet below the ground surface.[10] The preliminary geotechnical report for that portion of the project area indicates that most of the unconsolidated sediments underlying the site are not susceptible to liquefaction. However, several discontinuous 1- to 3-foot thick layers of saturated medium dense sand and silty sand and a 5-foot thick layer of medium dense silty sand identified in the subsurface investigations may be susceptible to liquefaction and could cause settlements at the surface of up to 1 inch.[11]

Shallow (less than 50 feet) groundwater levels and heterogeneous alluvial sediment would be expected throughout the project area. Therefore, site-specific evaluation of the liquefaction potential at individual development sites would be necessary to characterize the possible impacts related to liquefaction.

(4) Slope Stability. The project site is relatively level and would not be expected to be susceptible to slope instability hazards.

(5) Differential Settlement. Subsidence and differential settlement could occur if buildings are built on low strength foundation materials (including the imported fill). Pilings are often used to anchor structures to firmer deposits below the surface in these situations. Although differential settlement generally occurs slowly enough that its effects are not serious, significant building damage can occur. Any areas of the project area that contain uncontrolled (non-engineered) fill may be susceptible to settlement.

c. San Jose General Plan Policies. Seven key General Plan policies specifically address soils and geology or hazards.

- <u>Soils and Geologic Conditions Policy 1</u>: The City should require soils and geologic review of development proposals to assess such hazards as potential seismic hazards, surface ruptures, liquefaction, land-sliding, mud-sliding, erosion, and sedimentation in order to determine if these hazards can be adequately mitigated.
- <u>Soils and Geologic Conditions Policy 6</u>: Development in areas subject to soils and geologic hazards should incorporate adequate mitigation measures.
- <u>Soils and Geologic Conditions Policy 8</u>: Development proposed within areas of potential geological hazards should not be endangered by, nor contribute to, the hazardous conditions on the site or on adjoining properties.
- <u>Soils and Geologic Conditions Policy 9</u>: Residential development proposed on property formerly used for agricultural or heavy industrial uses should incorporate adequate mitigation/remediation for soils contamination as recommended through the Development Review process.

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[9] Webster, D., 1973. Map Showing Areas Bordering the Southern Part of the San Francisco Region where a High Water Table May Adversely Affect Land Use, U.S. Geological Survey Misc. Field Studies MF-530, scale 1:10000.

[10] Treadwell and Rollo, 2001. *Geotechnical Investigation, North Market and West Julian Site, San Jose, California*. Prepared for Legacy Partners, February 5.

[11] Ibid.

- Earthquake Policy 1: The City should require that all new buildings be designed and constructed to resist stresses produced by earthquakes.
- Earthquake Policy 4: The location of public utilities and facilities, in areas where seismic activity could produce liquefaction should only be allowed if adequate mitigation measures can be incorporated into the project.
- Hazards Policy 1: Development should only be permitted in those areas where potential danger to the health, safety, and welfare of the residents of the community can be mitigated to an acceptable level.

2. Impacts and Mitigation Measures

This section outlines potential impacts related to geology, soils, and seismicity and recommends mitigation measures. Less-than-significant impacts are described first, followed by significant impacts.

a. Criteria of Significance. Implementation of *Strategy 2000* would have significant impacts related to geology if it would have any of the following effects:

- Expose significant numbers of people or structures to rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault;
- Expose people or structures to major geologic hazards that could result in loss, injury, or death related to strong seismic ground-shaking or seismic-related ground failure, including liquefaction or landslides;
- Result in substantial soil erosion or the loss of topsoil;
- Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse; or
- Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property.

b. Less-Than-Significant Geology Impacts. Development of the proposed project would not be affected by slope instability or volcanic hazards. The project would not be expected to contribute to regional subsidence or long-term erosion hazards.

c. Significant Geology Impacts. Three potentially significant impacts are evaluated below. With implementation of each recommended mitigation measure, these impacts would be reduced to less-than-significant levels.

Impact GEO-1: Occupants of new development, (e.g., dwelling units and commercial space) associated with implementation of *Strategy 2000* would be subject to seismic hazards. (S)

All structures in the Bay Area and their occupants are at risk of damage or injury from ground shaking in the event of an earthquake. The amount of ground shaking would depend on the magnitude of the earthquake, the distance from the epicenter, and the type of earth materials in between. Very strong to violent ground shaking will occur in the project area during expected earthquakes on the

Hayward and other regional faults. This level of seismic shaking could cause extensive non-structural damage in buildings in the Greater Downtown. In addition, limited structural damage may occur.

Mitigation Measure GEO-1: Prior to the issuance of any site-specific grading or building permits, a design-level geotechnical investigation shall be prepared and submitted to the City of San Jose Public Works Department for review and confirmation that the proposed development fully complies with the California Building Code and the requirements of City Ordinance No. 25015 and Building Division Policy No. SJMC 24.02.310-4-94. The report shall determine the project site's surface geotechnical conditions and address potential seismic hazards, such as liquefaction and subsidence. The report shall identify building techniques appropriate to minimize seismic damage. In addition, the following requirement for the geotechnical and soils report shall be met:

- Analysis presented in the geotechnical report shall conform to the California Division of Mines and Geology recommendations presented in the "Guidelines for Evaluating Seismic Hazards in California."[12]

All mitigation measures, design criteria, and specifications set forth in the geotechnical and soils report shall be followed. (LTS)

It is acknowledged that seismic hazards cannot be completely eliminated even with site-specific geotechnical investigation and advanced building practices (as provided in the mitigation measure above). However, exposure to seismic hazards is a generally accepted part of living in the San Francisco Bay Area and therefore the mitigation measures described above reduce the potential hazards associated with seismic activity to a less-than-significant level.

Impact GEO-2: Damage to structures or property related to shrink-swell potential and/or settlements of soils in the Greater Downtown area could occur. (S)

Soils underlying portions of the entire project area have moderate to high shrink/swell potential.[13] This condition occurs when expansive soils undergo alternate cycles of wetting (swelling) and drying (shrinking). During these cycles, the volume of the soil changes significantly. In addition, non-uniformly compacted imported fill that has potentially been placed in the area could experience significant differential settlements under new building loads. Structural damage, warping, and cracking of roads and sidewalks, and rupture of utility lines may occur if the potential expansive soils and the nature of the imported fill were not considered during design and construction of improvements.

Mitigation Measure GEO-2: In locations underlain by expansive soils and/or non-engineered fill, the designers of proposed building foundations and improvements (including sidewalks, roads, and utilities) shall consider these conditions. The design-level geotechnical investigation (required by Mitigation Measure GEO-1) shall include measures to ensure that potential damage related to expansive soils and non-uniformly compacted fill are minimized. Options to address these conditions may range from removal of the problematic soils and replacement, as

[12] California Division of Mines and Geology (CDMG), 1997. *Guidelines for Evaluating Seismic Hazards in California*, CDMG Special Publication 117, 74 p.

[13] U.S. Department of Agriculture, 1968. Soils of Santa Clara County.

needed, with properly conditioned and compacted fill, to design and construction improvements to withstand the forces exerted during the expected shrink-swell cycles and settlements. (LTS)

All mitigation measures, design criteria, and specifications set forth in the geotechnical and soils report shall be followed to reduce impacts associated with shrink-swell soils to a less-than-significant level.

Impact GEO-3: Dewatering-related subsidence and potential earth movements associated with temporary shoring systems could cause settlement and damage to existing structures, roadways, and/or utilities. (S)

Dewatering of the subsurface, which would be required during and potentially after construction of below-ground structures (including some foundation elements), could result in a lowered groundwater level in portions of the project area. The lowered water level would increase the effective stress on the underlying sediments, potentially resulting in settlements that could affect existing improvements. In addition, it has been estimated that shoring systems could allow earth movements of up to 1 inch, creating further potential for damage to existing improvements.

Mitigation Measure GEO-3: The design-level geotechnical investigation (required by Mitigation Measure GEO-1) shall evaluate the consolidation properties of the underlying sediments to determine the potential for settlements associated with dewatering and other potential earth movements. If it is determined that unacceptable settlements may occur with either active or passive dewatering systems, then alternative groundwater control systems that do not require continuous groundwater removal (e.g., slurry wall) shall be required. (LTS)

Full implementation of all mitigation measures, design criteria, and specifications set forth in the geotechnical and soils report would reduce potential impacts associated with settlement due to dewatering to a less-than-significant level.